GE Power & Water
Renewable Energy

# Introducing GE's **1.6-100**

## Best-in-class capacity factor

a product of
**eco**magination

imagination at work

## Introducing GE's **1.6-100**

Product evolution. It's one of the things GE does best.  Especially when it comes to the next generation of wind turbines. Building on a strong power generation heritage spanning more than a century, our onshore wind turbines deliver proven performance, availability and reliability—creating more value for our customers.

As one of the world's leading wind turbine suppliers, GE Energy's current product portfolio includes wind turbines with rated capacities ranging from 1.5 MW–4.1 MW and support services extending from development assistance to operation and maintenance.

# GE's 1.6-100 Wind Turbine

GE's 1.6-100 wind turbine offers a 47% increase in swept area when compared to the 1.6-82.5 turbine, resulting in 19% increase in Annual Energy Production (AEP) at 7.5 m/s. This increase in blade swept area allows greater energy capture and improved project economics for wind developers. GE's 1.6-100 turbine has a 53% gross capacity factor, at 7.5 m/s; a class leading performance. GE's proprietary 48.7 meter blade uses the same proven aerodynamic shape as the blades found on the 2.5-100 turbine, but with the use of carbon fiber the weight is significantly reduced from the original blade predecessor.

GE's stringent design procedures result in a turbine designed for high performance, reliability and availability. The use of the rotor from the proven GE 2.5-100 turbine and selected component modifications provide increased annual production with the same reliable performance as the 1.5 MW series turbine.

Available in 80 meter and 100 meter tower heights, these sizes provide flexible options for Class III wind sites, allowing for higher energy capture in lower wind speed environments.

# Building Upon the Proven 1.5 MW and 2.5 MW Platforms

The evolution of GE's 1.5 MW turbine design began with the 1.5i turbine introduced in 1996. The 65 meter rotor was increased to 70.5 meters in the 1.5s then to 77 meters in the 1.5sle turbine which was introduced in 2004. Building on the exceptional performance and reliability of the 1.5sle, GE introduced the 1.5xle with its 82.5 meter diameter in 2005. Subsequent improvements in design led to the 1.6-82.5 turbine, introduced in 2008. Ongoing investment in the industry workhorse resulted in the introduction of GE's 1.6-100 wind turbine with a 100 meter rotor. This product evolution ensures increased capacity factor while increasing AEP by 19%.

Incremental changes to the 1.6-100 resulted in a significant performance increase. These enhancements include greater blade length, use of carbon fiber, Low Noise Trailing Edge (LNTE) and gearbox improvements resulting in an increase in AEP, high capacity factor, and controlled sound performance.

GE's new, Low Noise Trailing Edge serrations are employed on this turbine to enable tailored sound as a function of wind speed for a smaller sound footprint and optimized park layout to increase AEP. Testing has shown this design for the blade enables improved turbine acoustic performance. Designed with high reliability to ensure continued operation in the field, GE's 1.6-100 can provide excellent availability comparable with the 1.5 MW series units operating in the field today.

# Technical Description

GE's 1.6-100 wind turbine is a three-blade, upwind, horizontal axis wind turbine with a rotor diameter of 100 meters. The turbine rotor and nacelle are mounted on top of a tubular steel tower providing hub heights of 80 meters and 100 meters. The machine uses active yaw control to keep the blades pointed into the wind. The turbine is designed to operate at a variable speed and uses a doubly fed asynchronous generator with a partial power converter system.

**Specifications:**

1.6-100 Wind Turbine:

- Designed to IEC 61400-1
  — TC III: 7.5 m/s average wind speed; B turbulence intensity
- Standard and cold weather extreme options
- Standard tower corrosion protection; C2 internal and C3 external with optional C4 internal and C5 external available
- Rotational direction: Clockwise viewed from an upwind location
- Speed regulation: Electric drive pitch control with battery backup
- Aerodynamic brake: Full feathering of blade pitch

# Features and Benefits

- Higher AEP than its 1.6 predecessors
- Highest capacity factor in its class
- Designed to meet or exceed the 1.5 MW platform's historic high availability
- Grid friendly options are available
  — Enhanced Reactive Power, Voltage Ride Thru, Power Factor Control
- Wind Farm Control System; WindSCADA*
- Sharing of components with family products
- GE proprietary 48.7 meter blade
- Ultra-quiet power production Low Noise Trailing Edge serrations as an acoustic enhancement for the 1.6-100
- Available in both 50 Hz and 60 Hz versions for global suitability

# Construction

**Towers:** tubular steel sections provide variable hub heights from 80 meters to 100 meters

**Blades:** GE 48.7 meter blades with Low Noise Trailing Edge serrations

- Providing high energy capture with low sound emission
- Carbon spar caps within blades reduce weight, which reduces turbine loads

**Drivetrain components:** GE's 1.6-100 uses proven design gearboxes, mainshaft and generators with appropriate improvements to enable the larger rotor diameter on the 1.6 MW machine

# Enhanced Controls Technology

The 1.6-100 wind turbine employs two enhanced control features:

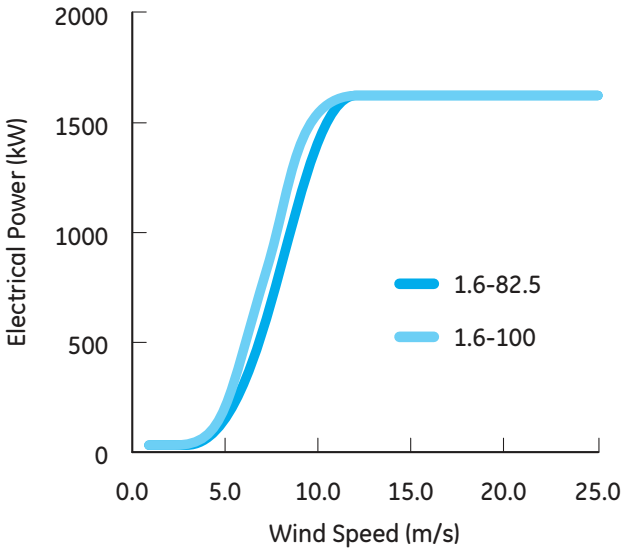
- GE's patented Advanced Loads Control reduces loads on turbine components by measuring stresses and individually adjusting blade pitch
- Controls developed by GE Global Research minimize loads including at near rated wind speeds to improve Annual Energy Production (AEP)

# Condition Based Monitoring

GE's Condition Based Monitoring (CBM) and SCADA Anomaly Detection Services, a complementary suite of advanced condition monitoring solutions, proactively detect impending drive train and whole-turbine issues enabling increased availability and decreased maintenance expenses. Built upon half a century of power generation drivetrain and data anomaly monitoring experience, this service solution is available as an option on new GE Units and as an upgrade.

# 1.6-100 Specifications

## Power Curve Improvement




# Highest capacity factor in its class

- **Value.** Best in Class Capacity Factor, 52% @ 7.5 m/s
- **Reliability.** GE fleet at 98%+ availability
- **Experience.** 16,500+ fleet, most 100 meter+ rotors, 1.5 million operating hours
- **Finance-ability.** Evolutionary design using "proven technology" from GE 1.5 MW and 2.5 MW platforms

*1.6 MW wind turbine, Tahachapi, California, U.S.A.*

# Powering the world...responsibly.

For more information please visit www.ge-energy.com/wind.



GEA18628 (04/2011)

GE Power & Water
Renewable Energy

fact sheet

# 1.6-100 Wind Turbine

## Introduction

GE continues to advance its 1.5 MW wind turbine series product line with the introduction of GE's 1.6-100 meter wind turbine. GE's 1.5 MW wind turbine series, also known as the industry workhorse, has an installed base of more than 16,000 turbines worldwide. Building on its exceptional turbine performance and reliability, GE introduces the 1.6-100 meter wind turbine.

This latest development in turbine technology increases the rotor diameter on the 1.6 from 82.5 meters to 100 meters, increasing the capacity factor.

Focusing on performance, reliability, efficiency, and multi-generational product evolution, GE's 1.6-100 meter wind turbine creates more value for our customers.

## Applicable Platforms

For use worldwide in IEC Type Class III environments, GE's 1.6-100 wind turbine is available for delivery in 2012.

## Technical Description

Ensuring consistent workhorse performance, reliability and efficiency, GE's new 1.6-100 meter wind turbine advances its 1.5 MW wind turbine series by leveraging proven and certified design from the 2.5 MW wind turbine series, which has over 460 installed units.

## Commercial

- Approved to quote with firm pricing
- Available for 2012 delivery

## Features and Benefits

- GE's new 1.6-100 meter wind turbine has a 47% increase in swept area relative to the 1.6-82.5 meter wind turbine, resulting in increased Annual Energy Production (AEP).
- Maximizing 1.5 MW and 2.5 MW platform components for 20-year design life and third party certification to support serial production

## Product Specifications

GE's 1.6-100 meter wind turbine IEC Type Class III offers the following technical specifications:

- GE's 1.6 generator
- 100 meter rotor diameter
- 48.7 meter blades
- 50/60 Hz
- 80 meter/100 meter tower configurations
- IEC Type Class III

## Powering the world...responsibly.

For more information, please visit www.ge-energy.com/wind



GEA18178C (05/2011)

# Wind Turbine Generator - WTG (ESS)

**1.x MW Doubly-Fed Induction Generator**

WTG Rotor

Stator

Rotor

Gear Box

Slip Ring

Incremental Encoder

690VAC

Position/ Speed

Stator Bus Bars
**1600 A**
(Nameplate Rating)

Rotor Bus Bars
**640 A**
(Nameplate Rating)

**640 A** (Per CSA Cert.)

**1397 A**
(Per CSA Cert.)

ROVC1,2,3

Rotor Over-Voltage Contactor (Crowbar)

Phase-To-Phase Connection

L2
25µH
750A

"Stator Feedback"

CT4, 5, 6
1500:1
5VA, 0.5%

Current

Q6, 1A

Voltage

3-Pole

R

Rotor Converter

C

DC Link

Line Converter

R

**DTA Cabinet**

K1
Contactor
(Sync Switch)

"Grid Feedback"

Current

Voltage

L1
150µH
375A

LF

KDF R C

Line Filter (Distortion)

Phase-To-Phase Connection

ACLFU1, 2, 3
350A

690VAC

**274 A**

Q1
2000A
Motor Operated
(Certified At
1598.66A)

CCONT CCR1, 2, 3

3-Pole

DC Link Charging Circuit

For Continuation See S/L Diagram Sht 2, 3 & 4

To Top Box (690 VAC)

T2
32.5 kVA
690 – 400/230,
- 208/120,
or – 173/100

Q2, 1A
3-Pole

Q5, 1A
3-Pole

FB3
80A
(3 Ph)

FB4
40A
(3 Ph)

FU1A, B, C
355A

Arc Flash

FB1
200A
(3 Ph)

FB2
100A
(3 Ph)

Q3, 1A
3-Pole

**1589 A**
(Per CSA Cert.)

Lightning Arrestor (Spark Gap)
F1, 2, 3

Surge Suppressor (MOV)
F4, 5, 6

Current

Voltage

"Grid Feedback"

CT1, 2, 3
1500:5
10VA, 0.5%

To Optional Energy Meter

690VAC,
3 Phase
"Low Voltage"

1750 kVA
Step-Up
Transformer

Pad-Mount Transformer

MV AC,
3 Phase
"Medium Voltage"

**DRAWING FOR CONCEPTUAL ILLUSTRATION ONLY – NOT FOR DETAILED DESIGN**
**PAD MOUNT TRANSFORMER PROTECTION SYSTEM MAY VARY FOR EXAMPLE**

*GE Energy Wind Systems*

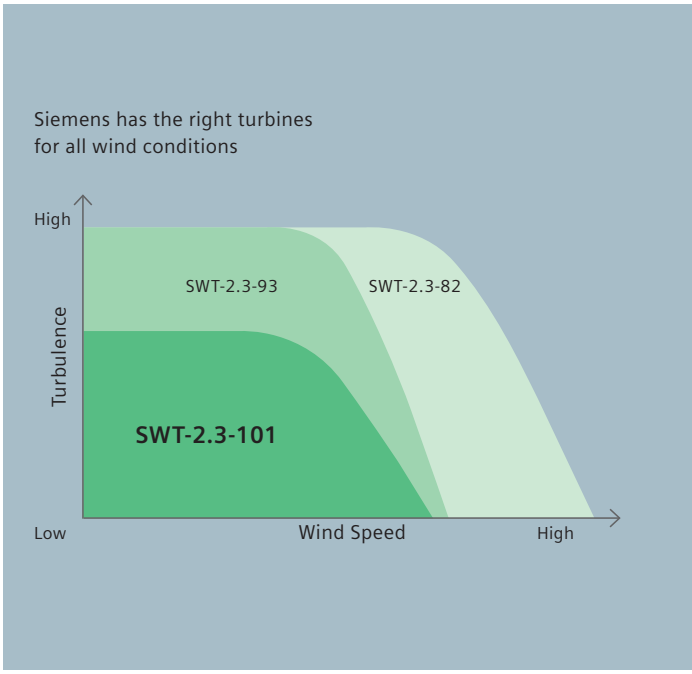
| 1.x MW WTG Power S/L Diagram | | |
|---|---|---|
| XXXX | 11-APR-2011 | Sht 1 of 1 |


# The new standard for moderate wind conditions

**Siemens Wind Turbine SWT-2.3-101**

Answers for energy.

SIEMENS




# Your trusted partner

**Siemens has been a major driver of innovation in the wind power industry since the early 1980s when wind turbine technology was still in its infancy.**

Technology has changed with the times, but Siemens' commitment to providing its customers with proven wind turbine solutions remains the same.

The combination of robust and reliable turbines, highly efficient solutions for power transmission and distribution and a deep understanding of the entire energy market ensures that Siemens will continue to be a leading supplier.

Siemens' record, when it comes to on-time delivery, is impeccable. Long-lasting customer relationships, based on the successful installation of wind turbines, provide for a sound, sustainable and profitable investment.

Drawing on 140 years of experience in the energy sector, a strong focus on renewables and a global network of highly skilled and trained employees, Siemens has proven itself to be a trustworthy and reliable business partner. And will continue to be in the future.

# Harvest more energy from sites with moderate wind conditions

**The Siemens SWT-2.3-101 turbine is designed to deliver unparalleled performance and reliability, making it especially suited to areas with moderate wind conditions.**

The SWT-2.3-101 turbine offers low energy production costs and joins Siemens' 2.3-MW product family, which has proven availabilitity that is among the highest in the industry. The 101-meter rotor is specifically designed to optimize the energy output in areas with moderate wind conditions. The turbine is also ideal for all types of grid connections in most major markets.

The SWT-2.3-101 is designed to last. The robust and reliable design offers a high yield with low maintenance costs. The turbine is backed by advanced condition monitoring and diagnostics, which constantly examine the turbine. Any change in a turbine's performance is promptly addressed by an experienced after-sales service team either remotely or in the field.

If you desire a better return on investment and superior availability, take a closer look at the SWT-2.3-101 turbine.

# Superior performance gives higher yields

## Optimum energy at moderate wind conditions

### Harvesting more energy

The SWT-2.3-101 wind turbine is designed to increase the energy returns from sites with moderate wind conditions. Advanced blade technology also allows for quieter operation. The B49 blade with a rotor diameter of 101 meters and pitch regulation optimizes power output and increases control over the energy output.

### High availability

Currently, the Siemens fleet of 2.3-MW wind turbines sets the industry standard for availability. The SWT-2.3-101 will build on the reputation for reliability that the market has come to expect from a Siemens Wind turbine.

### High yield with minimal maintenance

Siemens optimizes the return on investment in its wind turbines through intelligent maintenance that ensures the turbine to deliver high yield with low operational costs.

The rugged structural design, combined with an automatic lubrication system, internal climate control and a generator system without slip rings contributes to exceptional reliability. The innovative design of the SWT-2.3-101 allows for longer service intervals.

### Superior grid compliance

The Siemens NetConverter® system is designed for maximum flexibility in the turbine's response to voltage and frequency variations, fault ride-through capability and output adjustment. The advanced wind farm control system provides state-of-the-art fleet management.

### Proven track record

Siemens has a proven track record of providing reliable turbines that last. The world's first offshore wind farm in Vindeby, Denmark, was installed in 1991 and is still fully operational. In California, Siemens installed over 1,100 turbines between 1983 and 1990, with 97% still in operation today. Siemens takes its commitment to reliability seriously and prides itself on the long lifespan that its turbines have demonstrated.

# No compromise on reliability

## SWT-2.3-101: Newest member of the extremely reliable product family

### Designed for life

Siemens turbines are designed to last. The robust design of the SWT-2.3-101 allows for trouble-free output throughout the complete lifecycle of the turbine.

The blades are made of fiberglass-reinforced epoxy in Siemens' proprietary IntegralBlade® manufacturing process. The blades are cast in one piece in a closed process, which eliminates the traditional weaknesses found at glue joints in other manufacturers' blades. Like the turbine itself, the blades are designed to last.

Climate control within the turbine protects vital equipment from the outside environment. The turbine also offers controlled-wear strategies for critical components, which results in a further reduction of maintenance costs.

### Safety first

Safety is at the heart of all Siemens operations. From production to installation, operation and service, Siemens strives to set the standard in safety.

The fail-to-safe capabilities within a turbine, combined with Siemens' superior lightning protection system, are designed to enhance security for the turbine.

### Advanced operations support

Given the logistical challenges associated with servicing wind farms, Siemens has equipped its turbines with a Turbine Condition Monitoring (TCM) system that reduces the need for on-site servicing.

Continuous monitoring of turbines allows for the discovery of small faults before they become major problems.

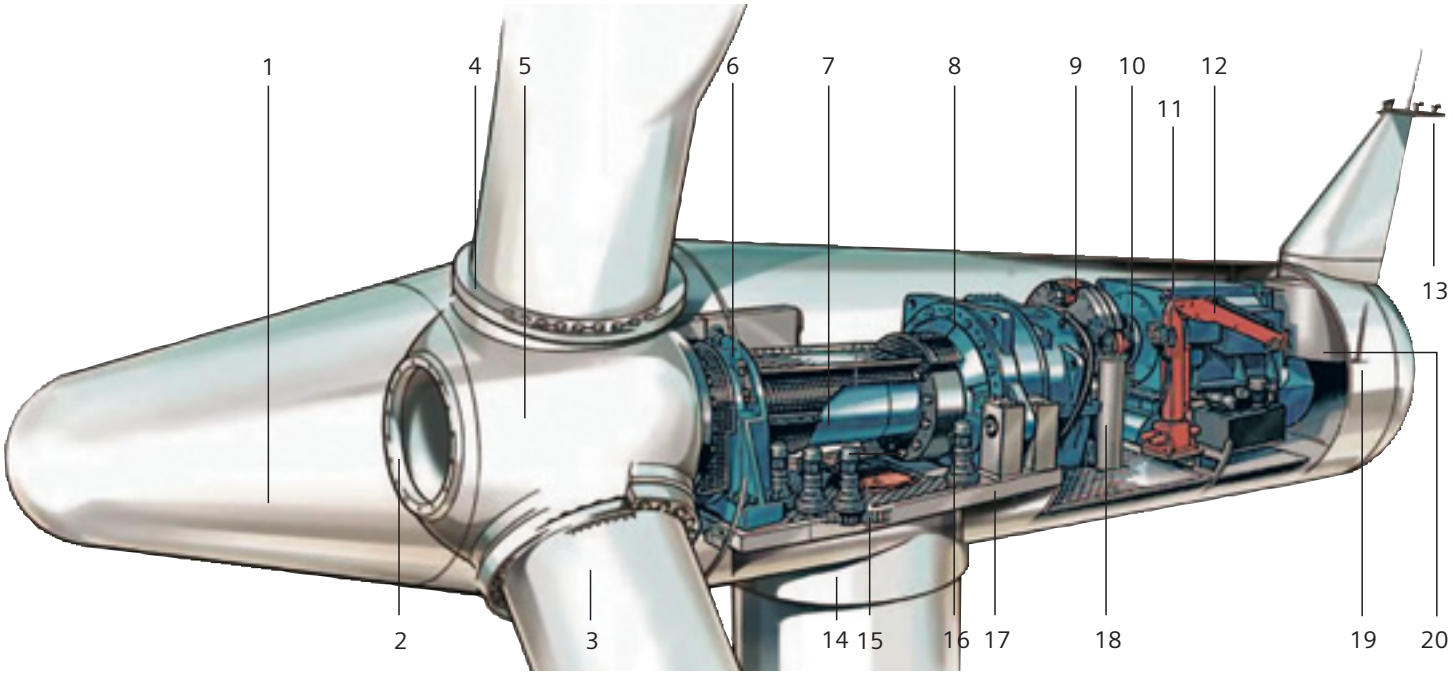
The TCM system continuously checks the external and internal condition of the wind turbine. Twenty-four hours a day, seven days a week precise measurements are taken of vibrations in the gearbox, the generator and the main shaft bearings. The system instantly detects deviations from normal operating conditions.

Using the knowledge gained from monitoring thousands of turbines over the years, Siemens' experts are exceptionally skilled at analyzing and predicting faults within a turbine. This allows Siemens to proactively plan the service and maintenance of the turbines as each fault can be categorized and prioritized based on the severity of the fault. Siemens can then determine the most appropriate course of action to keep the turbine running at its best.

# Technical specifications

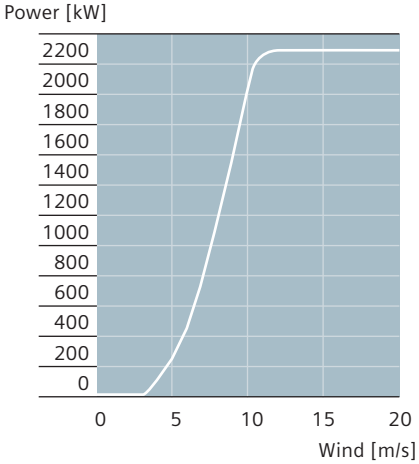
| | |
|---|---|
| **Rotor** | |
| Diameter | 101 m |
| Swept area | 8,000 m2 |
| Rotor speed | 6-16 rpm |
| Power regulation | Pitch regulation with variable speed |
| **Blades** | |
| Type | B49 |
| Length | 49 m |
| **Aerodynamic brake** | |
| Type | Full-span pitching |
| Activation | Active, hydraulic |
| **Transmission system** | |
| Gearbox type | 3-stage planetary/helical |
| Gearbox ratio | 1:91 |
| Gearbox oil filtering | Inline and offline |
| Gearbox cooling | Separate oil cooler |
| Oil volume | Approximately 400 l |
| **Mechanical brake** | |
| Type | Hydraulic disc brake |
| **Generator** | |
| Type | Asynchronous |
| Nominal power | 2,300 kW |
| Voltage | 690 V |
| Cooling system | Integrated heat exchanger |

| | |
|---|---|
| **Yaw system** | |
| Type | Active |
| **Monitoring system** | |
| SCADA system | WebWPS |
| Remote control | Full turbine control |
| **Tower** | |
| Type | Cylindrical and/or tapered tubular |
| Hub height | 80 m or site-specific |
| **Operational data** | |
| Cut-in wind speed | 3-4 m/s |
| Rated power at | 12-13 m/s |
| Cut-out wind speed | 25 m/s |
| Maximum 3 s gust | 55 m/s (standard version)<br>60 m/s (IEC version) |
| **Weights** | |
| Rotor | 62 tons |
| Nacelle | 82 tons |
| Tower for 80-m hub height | 162 tons |




### Sales power curve

The calculated power curve data are valid for standard conditions of 15 degrees Celsius air temperature, 1013 hPa air pressure and 1.225 kg/m³ air density, clean rotor blades and horizontal, undisturbed air flow. The calculated curve data are preliminary.




### Nacelle arrangement

1. Spinner
2. Spinner bracket
3. Blade
4. Pitch bearing
5. Rotor hub
6. Main bearing
7. Main shaft
8. Gearbox
9. Brake disc
10. Coupling
11. Generator
12. Service crane
13. Meteorological sensors
14. Tower
15. Yaw ring
16. Yaw gear
17. Nacelle bedplate
18. Oil filter
19. Canopy
20. Generator fan

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Renewable Energy Division
Order No. E50001-W310-A121-X-4A00
Printed in Germany
Dispo 34804, c4bs No. 7491
fb 2225 WS 10095.

Printed on elementary chlorine-free bleached paper.



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Vestas®

# V100
# 1.8 MW

**Wind.** It means the world to us.™

# V100-1.8 MW
# Opening up a new world of opportunities

### Extracts power from extremely low winds thanks to its 49 m blades

This V100-1.8 MW turbine allows you to increase productivity by opening up low-wind onshore sites that you previously regarded as non-viable. To maximise power output at such locations, this turbine's 100 m rotor squeezes more from the available wind – starting at an incredibly low 3 m/s. Thanks to its 49 m blades, the V100-1.8 MW delivers a remarkable rotor-to-generator ratio that produces a capacity and yield that's higher than was once thought possible at low wind sites.

### The platform is tested and tried more than 7,800 times

What's more, the V100-1.8 MW is based on the mature and reliable Vestas 2 MW platform. Vestas has installed over 7,800 of its 2 MW turbines around the world since 1995, which is now enhanced to maximise your output and revenues.

The 2 MW class is the most thoroughly tested turbine on the market, with a proven availability of over 97% in 2009. And now this platform has been improved once again and has a new standard-bearer: The V100-1.8 MW – specifically designed for low-cost energy production at low-wind onshore sites.

**+7,800**

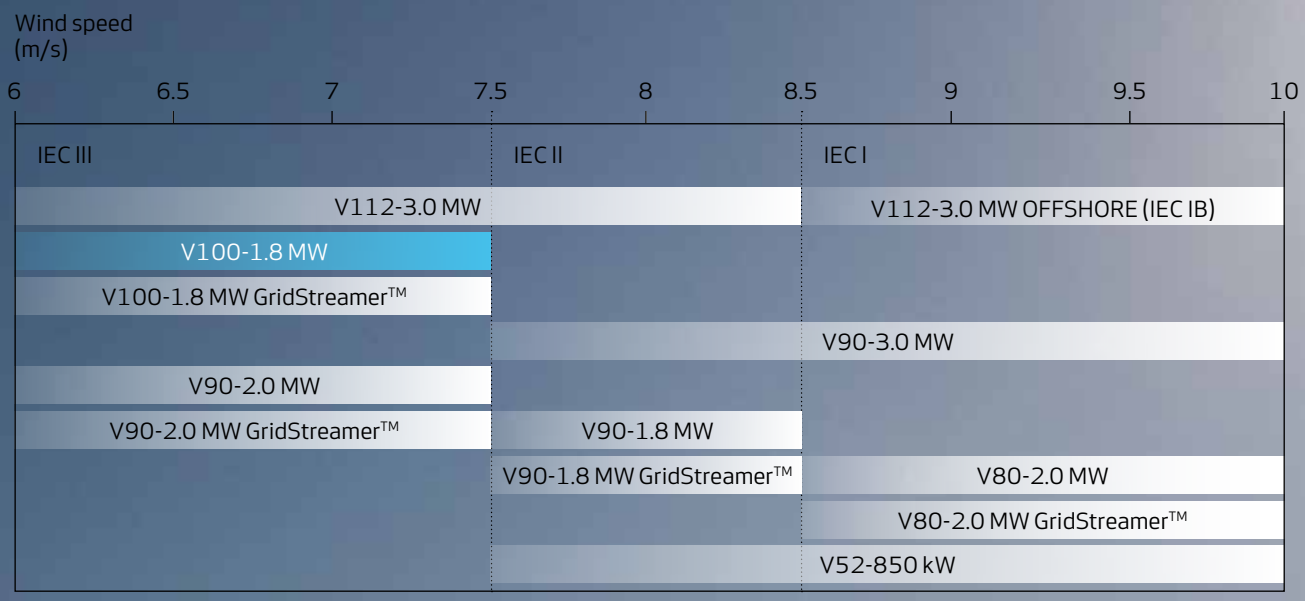
2 MW turbines installed worldwide
+15 GW installed
+97% availability


**Wind.** It means the world to us.™ Wind is all we do. We are relentlessly committed to the success of wind as a source of energy for the world, providing everything you need to succeed in your wind power ambitions.

# Low wind Strong **technology**

# **Unprecedented** productivity, reliability and performance

**If you want to ensure the yield of your low-wind (IEC IIIA) locations, the reliable V100-1.8 MW is an excellent choice.**




■ – 100 meter rotor diameter
■ – 1.8 MW rated power

## Optimise energy production

- Designed for high productivity
- Noise mode that minimises noise at low-wind with minimal impact on power production
- Excellent grid support

## Reduce energy costs

- Low Balance of Plant (BOP), installation and transportation costs
- 24/7 remote control with VMP Global®
- Innovative CoolerTop®
- Designed for serviceability

## Secure your investment

- Proven technology
- Reliable and robust product
- Redesigned bed frame and main bearing housing
- Improved yaw system

Here's an overview of selected benefits that optimise your energy production, lower your operating costs and strengthen the business case for choosing the V100-1.8 MW.

# Industry-leading technology generates **more energy**


### Designed for high productivity

To allow you to exploit the low-wind sites that you had to ignore until now, Vestas took on the huge technical challenge of using longer blades without compromising safety or availability. We were able to overcome these issues thanks to a rigorous design process using advanced 3D tools, and the Vestas Test Centre's exhaustive assessment regime, which included both static and dynamic testing.

At 49 m long, the blades of the V100-1.8 MW sweep an area of 7,850 m² – a 23% increase compared to the V90-1.8/2.0 MW. This ensures that the V100-1.8 MW maximises energy production at even the lowest wind speeds, generating a higher capacity and yield compared to other turbines in the 2 MW class.

### Noise mode that minimises noise at low-wind with minimal impact on power production

The V100-1.8 MW has various noise modes to meet the operational sound-level restrictions specific to any site.

Thanks to the Vestas Converter System (VCS), the turbine is able to reduce the rotor speed and therefore the noise, which is a significant factor when considering the suitability of the V100-1.8 MW for an onshore site with low winds.

In fact, you can run this turbine in site-specific configurable modes, and keep within defined decibel ranges, without significantly reducing productivity. So even in areas where sound-level restrictions are in place, the V100-1.8 MW is a very versatile option.

### Excellent grid support

The VCS inside the V100-1.8 MW delivers a constant and consistent output to the grid. The system is able to maintain grid stability by quickly regulating the turbine's power provision when needed. It swiftly responds to faults and other grid disturbances. The VCS also lessens the load on the gearbox and other key components, reducing wear and tear.

# **Reduce** wind energy cost by design

### Low balance of plant (BOP), installation and transportation costs

Just like the other turbines in the Vestas 2 MW series, it's possible to easily transport the V100-1.8 MW (by rail, truck or barge) to virtually any site around the world. In terms of weight, height and width, all of its components comply with local and international limits for standard transportation. This ensures that you incur no unforeseen or unusual costs for getting the turbine on site.

In addition, the V100-1.8 MW can be built and maintained using tools and equipment that are standard within the installation and servicing industries – minimising the ongoing maintenance costs.

### 24/7 remote control with VMP Global®

To reduce the cost of energy, the V100-1.8 MW is equipped with VMP Global®, the latest turbine control and operation software from Vestas.

Developed to run this latest generation of Vestas turbines, the modular VMP Global® software package automatically manages the turbine around the clock and ensures that you're always able to generate the maximum power from your V100-1.8 MW. In addition, the application supports your site management by monitoring and troubleshooting the wind turbines – both onsite and remotely – to keep maintenance costs as low as possible.

### Innovative CoolerTop®

The CoolerTop® installed on the V100-1.8 MW uses the wind's own energy to generate the cooling required, rather than consuming energy generated elsewhere. The fact that the CoolerTop® has no moving parts means that it requires little maintenance, shaving costs once more. In addition, the absence of any electrical components ensures that the cooling system makes no noise and reduces the nacelle's energy consumption.

The CoolerTop® also allows for a temperature range of up to 40° C  without de-rating and without needing a high temperature option that would inevitably compromise the amount of space available within the nacelle.

### Designed for serviceablity

The service crews are helped by the overall design of the V100-1.8 MW, which, like all other Vestas turbines, shields every rotating part and positions components for easy access.

## CoolerTop®

- New feature designed for efficient cooling to maximise power production

## Gearbox

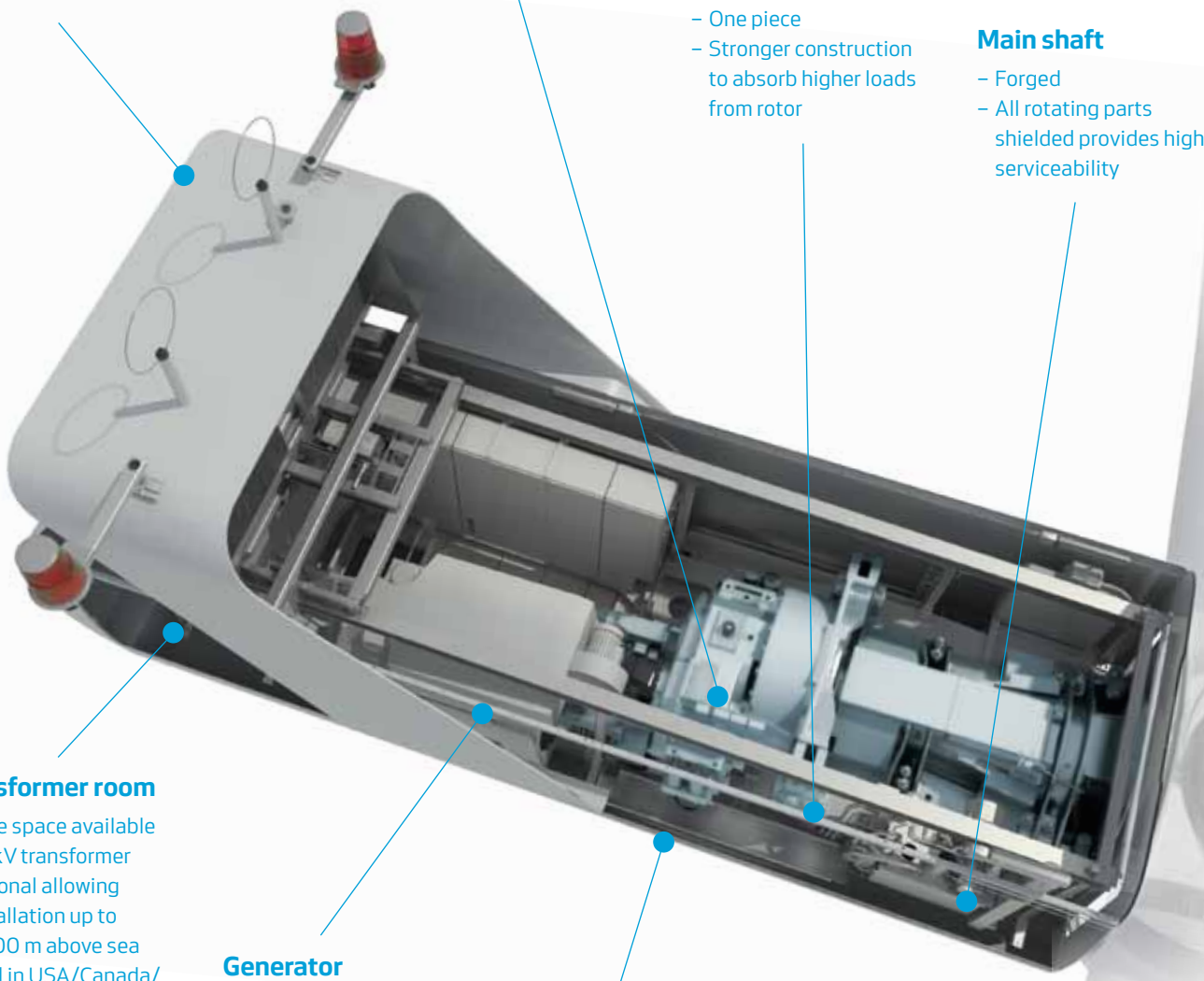
- Planetary gearbox with combined two-stage parallel gearbox

## Main-bearing housing

- One piece
- Stronger construction to absorb higher loads from rotor

## Main shaft

- Forged
- All rotating parts shielded provides higher serviceability



## Transformer room

- More space available
- 35 kV transformer optional allowing installation up to 2,000 m above sea level in USA/Canada/China

## Generator

- A reliable slip ring system
- Hybrid bearings with ceramic balls prevent bearing current for improved durability
- Improved generator cooling unit makes cooling effective

## Yaw system

- 6 yaw gears
- Automatic lubrication greasing
- Less downtime and higher energy production

## Blade

- Market-leading aerodynamic design
- Glass fibre and carbon fibre combination
- Single point greasing system, reducing service time

Our passion and commitment are **your guarantee** for safer business investments

## Proven technology

The V100-1.8 MW is based upon the proven technologies that underpin the +7,800 2 MW Vestas turbines installed around the world. Using the best features from across the range, as well as some of the industry's most stringently tested components and systems, this turbine's reliable design minimises downtime – helping to give you the best possible return on your investment.

## Reliable and robust product

The Vestas Test Centre is unrivalled in the wind industry and has the unique ability to test complete nacelles using a.o. Highly Accelerated Life Testing (HALT) to ensure reliability. At the critical component level, potential failure modes and mechanisms are identified, and specialised test rigs are used to ensure strength and robustness for the gearbox, generator, yaw and pitch system, lubrication system and accumulators.

The Vestas quality-control system ensures that each component is produced to validated design specifications, and performs at site. We also employ a Six Sigma philosophy and aim to perform at Six Sigma levels during 2011. We have identified critical manufacturing processes (both in-house and for sub-suppliers), and we systematically monitor measurement trends that are critical to quality, to identify variation and make changes before any defects occur.

## Redesigned bed frame and main bearing housing

Created with future generations of turbines in mind, the new single bed frame and stronger main bearing housing of the V100-1.8 MW provide a better foundation for loads.

The strengthened frame and housing – each made from single-piece castings – work in conjunction to absorb higher loads from the rotor. In addition, the housing ensures correct alignment during bearing assembly, making the process more accurate and efficient, and distributes loads evenly.

These improvements combine to increase the production capabilities of this turbine and to reduce downtime.

## Improved yaw system

Previous generations of turbines in the 2 MW class included a four-gear yaw system. But the Vestas commitment to continuous improvement means that the system included within the V100-1.8 MW is even better – it features a six-gear yaw system and 110 mm yaw rim that's been subjected to induction hardening, making it more robust and reliable than ever before.

The maintenance savings associated with this improvement are boosted yet further by the partly automatic yaw lubrication system fitted as standard on the V100-1.8 MW. This partly automated greasing mechanism delivers tangible service savings and raises revenues by increasing your uptime.

# **Full control** through service experts and our surveillance system

### Surveillance, maintenance and service

Vestas provides 24/7 monitoring, performance reporting and predictive maintenance systems to improve turbine uptime, production and availability. Operating a large wind power plant today calls for highly efficient management strategies, to ensure that power production is uninterrupted and that operational and maintenance expenses are controlled. The ability to predict when your critical components are most likely to break down is essential to this effort, as it helps to avoid costly emergency repairs and unscheduled interruptions to energy production.

The Vestas Condition Monitoring System performs this predictive maintenance function, assessing the status of the V100-1.8 MW by analysing measured signals such as vibrations and temperatures (e.g. in gearbox bearings and the main bearings). For example, by measuring the vibration of the drive train, the system can detect faults at an early stage and monitor the progress of the damage. This information allows the service organisation to plan and execute the required maintenance work before the component fails, reducing repair costs and production loss.

What's more, our Active Output Management® (AOM) concept provides detailed plans for service and maintenance, online monitoring, optimisation and troubleshooting, and includes a competitive insurance scheme. It is even possible to get a full availability guarantee, under which Vestas pays compensation if the turbine fails to meet the agreed availability targets.

### Vestasonline® Business

Vestas wind turbines benefit from the latest Supervisory Control and Data Acquisition (SCADA) system for modern wind power plants: VestasOnline® Business.

This flexible system includes an extensive range of monitoring and management functions that allow you to control your wind power plant in the same way as a conventional power plant. VestasOnline® Business enables you to optimise production levels, monitor performance and produce detailed, tailored reports from anywhere in the world while the system's power plant controller provides active and reactive power regulation, power ramping and voltage control.

Vestas turbines include a range of additional features that give you the control you need to maximise your production and ensure a high return on your investment. Thanks to our superior operations and maintenance capabilities, we also provide a level of service unparalleled in the industry.

# V100-1.8 MW
# Facts and figures

**POWER REGULATION** pitch regulated with variable speed

**OPERATING DATA**

| | |
|---|---|
| Rated power | 1,800 kW (50 Hz)<br>1,815 kW (60 Hz) |
| Cut-in wind speed | 3 m/s |
| Rated wind speed | 12 m/s |
| Cut-out wind speed | 20 m/s |
| Wind class | IEC S (IEC IIIA average wind/ IEC IIA extreme wind) |
| Operating temperature range | standard turbine:<br>-20 ° C to 40 ° C<br>low temperature turbine:<br>-30 ° C to 40 ° C |

**SOUND POWER MODES**

| | |
|---|---|
| Mode 0: Max sound power level: | 105.0 dB (A) |
| Mode 1: Max sound power level: | 105.0 dB (A)* |
| Mode 2: Max sound power level: | 103.0 dB (A) |

*) low noise at low wind

**ROTOR**

| | |
|---|---|
| Rotor diameter | 100 m |
| Swept area | 7,850 m² |
| Nominal revolutions | 14.5 rpm |
| Operational interval | 9.3 – 16.6 rpm |
| Air brake | full blade feathering with 3 pitch cylinders |

**ELECTRICAL**

| | |
|---|---|
| Frequency | 50/60 Hz |
| Generator type | 4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings |

**GEARBOX**

| | |
|---|---|
| Type | one planetary stage and two helical stages |

**TOWER**

| | |
|---|---|
| Type | tubular steel tower |
| Hub heights | 80 m and 95 m |

**BLADE DIMENSIONS**

| | |
|---|---|
| Length | 49 m |
| Max. chord | 3.9 m |

**NACELLE DIMENSIONS**

| | |
|---|---|
| Height for transport | 4 m |
| Height installed (incl. CoolerTop®) | 5.4 m |
| Length | 10.4 m |
| Width | 3.4 m |

**HUB DIMENSIONS**

| | |
|---|---|
| Max. diameter | 3.3 m |
| Max. width | 4 m |
| Length | 4.2 m |

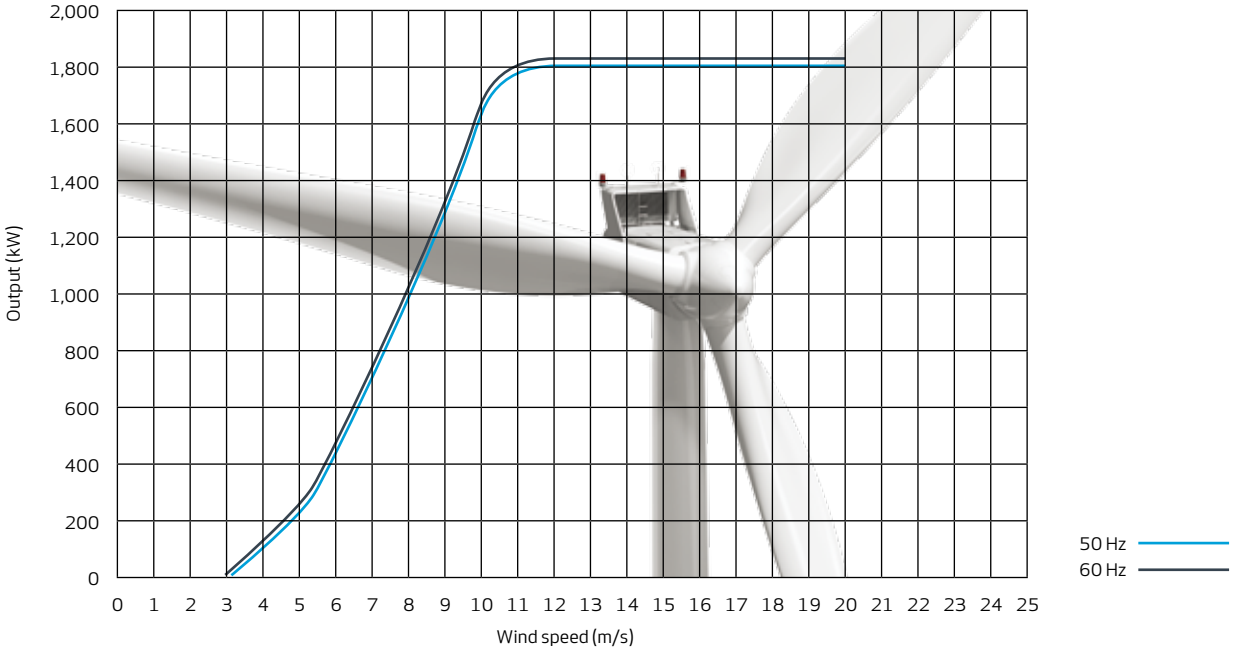
| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**+20,000**

committed, highly-trained employees around the globe are always ready to help in any aspect of wind power production.

**POWER CURVE FOR V100-1.8 MW**

Noise reduced sound power modes are available



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03/2011-EN